Picosecond Time Resolved Microscopy on Magnetic Structure Using X-PEEM

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Understanding magnetization dynamics on a small spatial and a fast temporal scales is of both fundamental and technological interest, as future magneto-electronic devices are getting smaller and faster down to a few tens of nanometer and a few hundreds of picosecond. On ps time scale the magnetization dynamics is determined by the fundamental spin processes of precession and damping whose microscopic origins are not well understood yet. For a time and spatially resolved microscopy technique, we have utilized the high spatial resolution Photoemission Electron Microscope PEEM-2 at the ALS and the intrinsic time resolution given by the ALS pulse width. The first observation results of x-ray magnetic microscopy on the 100 ps time scale and 100 nm length scale will be reported here. The ps time resolution was achieved by utilizing a pump-probe technique via synchronization between femtosecond laser pump for short magnetic pulse generation and ALS synchrotron x-ray probe for x-ray microscopy observation. Magnetic field pulse was created by current pulse, launched from a photoconductive switch through a lithographically produced waveguide structure. The switch was triggered by a fs laser, synchronized to the pulse train of the ALS, operated in two bunch mode. The fast evolution of magnetic domains was monitored as a function of the delay between the magnetic field pulse (pump) and the x-ray pulse (probe) using a stroboscopic pump-probe setup. The time resolved magnetization evolution images were analyzed within the context of micromagnetic consideration using the magnetic pulse profile, which was determined independently by utilizing the deflection of images due to the time dependent electric potential while current pulse flows through the waveguide.